

# Carbon dynamics in cacao agroforestry plantations setup after forest or savannah:

## A chronosequence analysis in a forest - savannah transition zone in Cameroon

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### Introduction

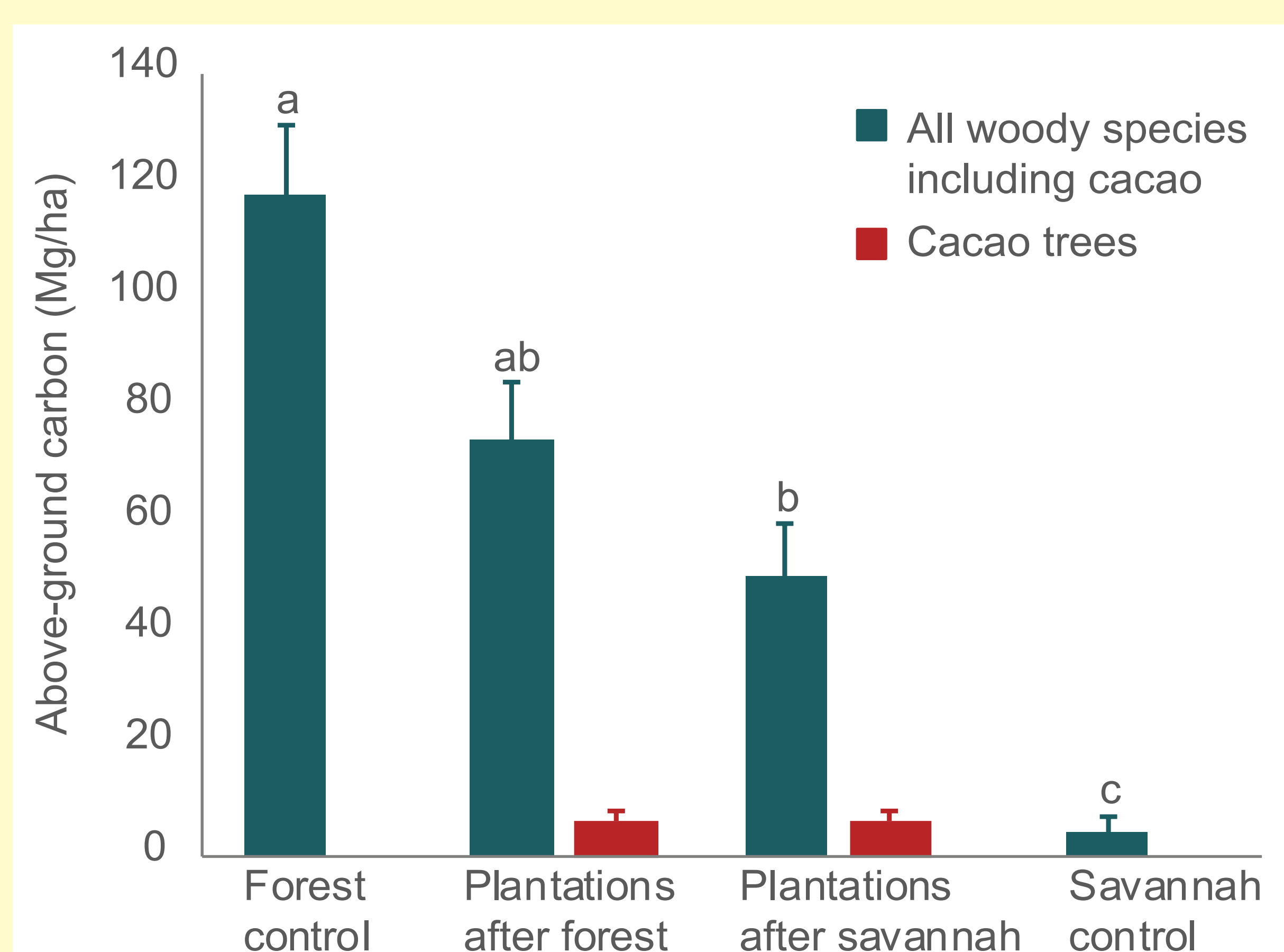
Previous studies in the forest-savannah transition zone of Bokito in Central Cameroon have shown that smallholder farmers were able to realize afforestation by creating cacao plantations on savannah land (Fig: 1)<sup>1,2</sup>. Compared to plantations setup after forest in the same region, cocoa production levels and associated tree species densities were found to be comparable on the long-term<sup>1</sup>. In the light of climate change, afforestation of savannah with cacao plantations could be of great potential due to its significant storage of carbon.

### Methods

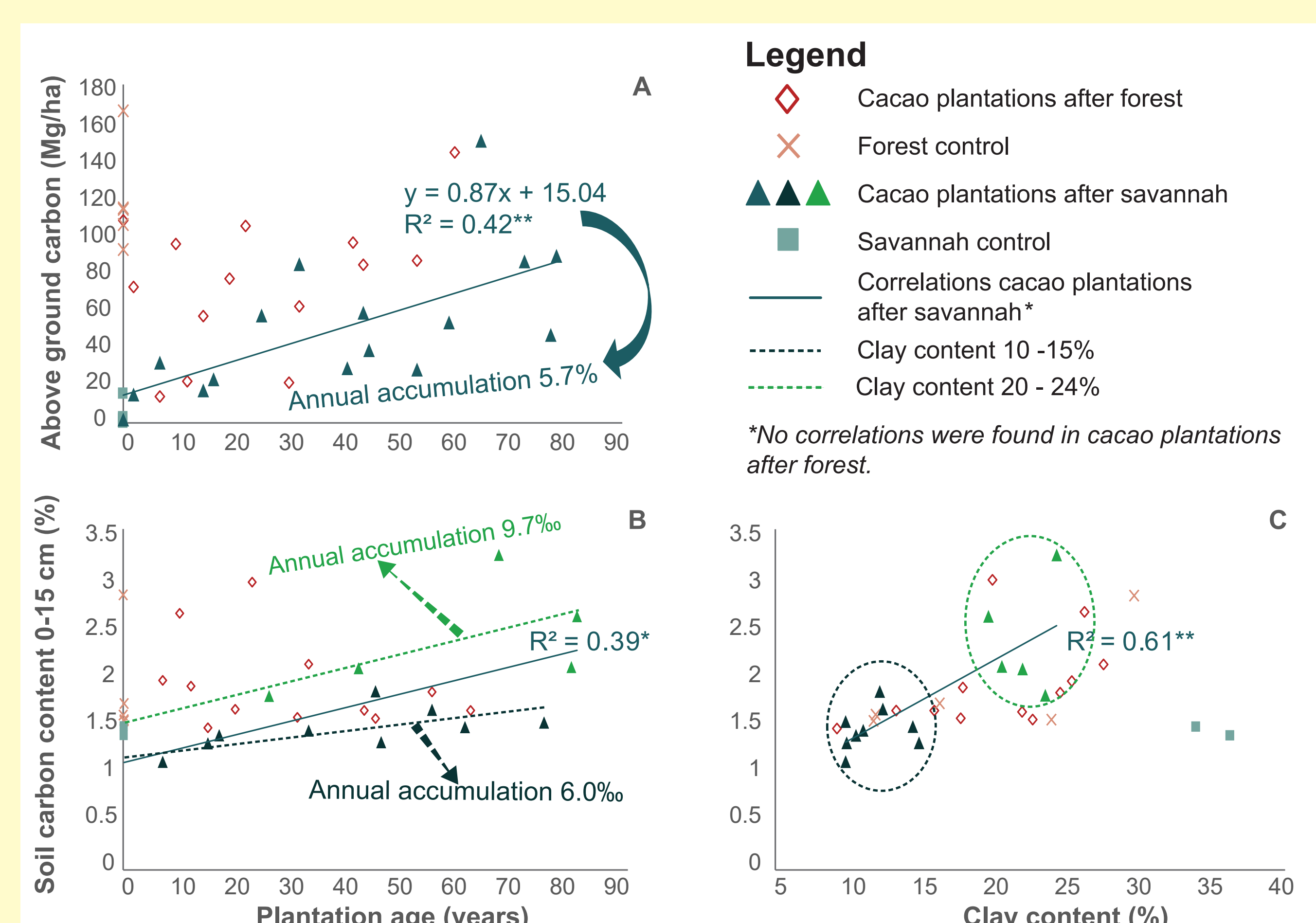
Field studies were conducted in Bokito in the central region of Cameroon. Plantations with an age gradient of 0 to 80 years were selected to assess aboveground carbon accumulation in cacao and associated trees as well as the soil carbon content. The two previous land-use types: savannah and gallery-forest were also included in the analysis for comparison.

### Results

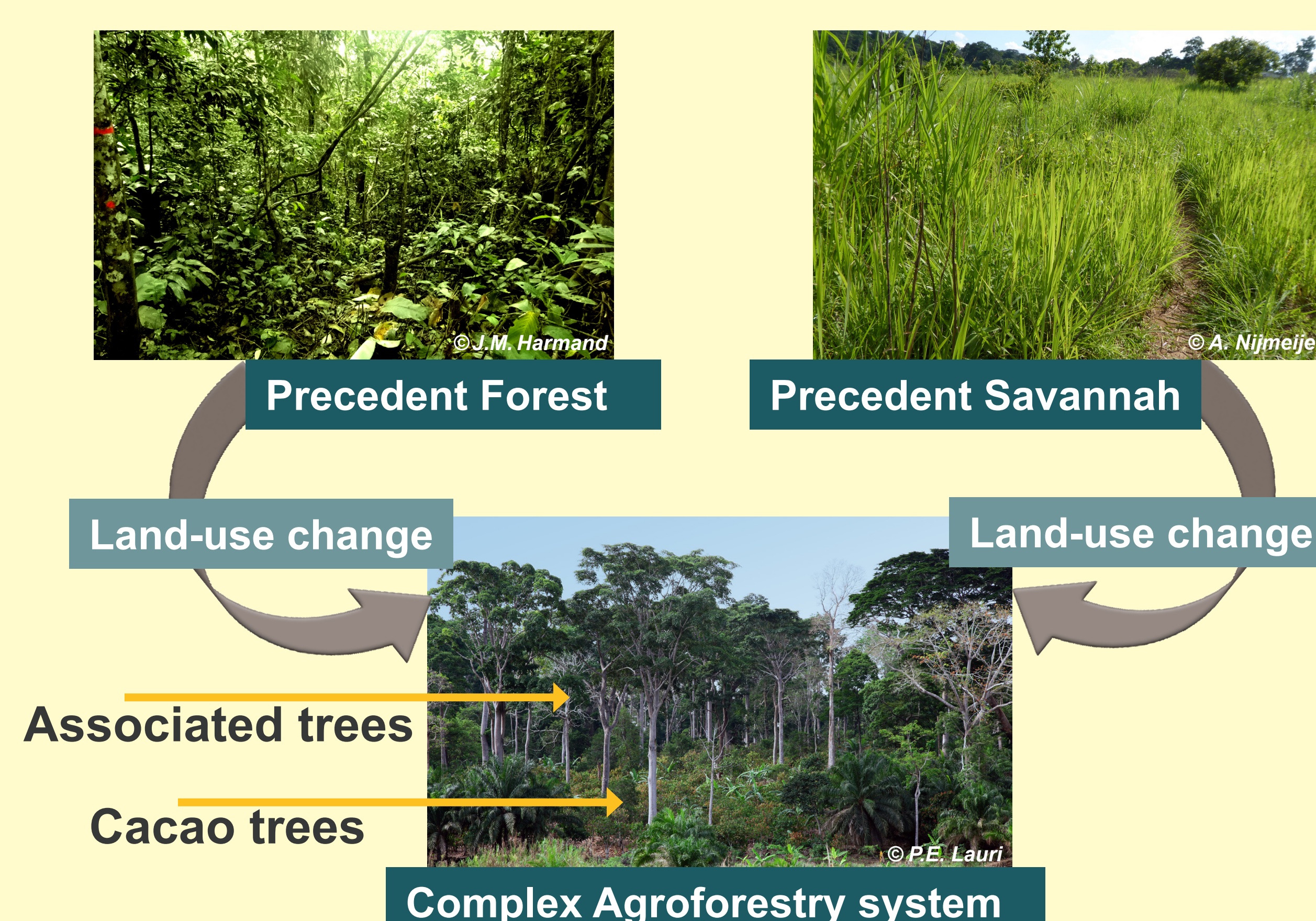
Total aboveground carbon (AGC) was found to be highest in the gallery-forest control plots (118 Mg ha<sup>-1</sup>) and lowest in the savannah control plots (trees and herbs: 8 Mg ha<sup>-1</sup>; Fig: 2).



**Fig. 2:** Mean total above ground carbon stocks in forest- and savannah control plots, cacao plantations after forest and after savannah.



**Fig 3:** Changes in (A) above ground carbon stocks and (B) soil carbon content with the plantation age. (C) Correlation between soil carbon content and soil clay content.



**Fig. 1:** What influence has converting savannah or forest to complex cacao agroforestry systems on the long-term carbon budgets?

Compared to their previous land uses, mean total AGC was around 40% lower in cacao plantations set-up after forest while AGC stocks of plantations set up after savannah have increased by 630%.

AGC of cocoa plantations after forest stayed relatively stable over time while it increased significantly ( $p < 0.01$ ) with the age of the plantations setup after savannah (Fig: 3A). According to the soil texture, different tendencies of soil C accumulation over time were found in cocoa plantations setup after savannah, while no change in soil C content was observed after forest over time (Fig: 3B, C).

### Conclusion

- Afforestation of savannah has a positive effect on the total above ground carbon with an annual accumulation of 5.7% resulting in similar carbon stocks as cacao plantations after forest in  $\pm 60$  years.
- Setting up a cacao plantation after forest decreases the mean above ground carbon stock but no significant change was shown with aging of the cacao plantations.
- For the two classes of soil texture found in the cocoa plantations setup after savannah, soil organic carbon increases with the plantation age.

### References

1. Jagoret, P., Michel-Dounias, I., Snoeck, D., Ngnogué, H. T. & Malézieux, E. Afforestation of savannah with cocoa agroforestry systems: a small-farmer innovation in central Cameroon. *Agrofor. Syst.* 86, 493–504 (2012).
2. Saj, S., Jagoret, P. & Todem Ngogue, H. Carbon storage and density dynamics of associated trees in three contrasting *Theobroma cacao* agroforests of Central Cameroon. *Agrofor. Syst.* 87, 1309–1320 (2013).

